memory depending on the inside temperature detected by the temperature sensor.

22. The ink-jet imaging apparatus according to claim 2, wherein the above ink ejection element is a heater element which generates heat, or a piezo element which causes a piezo electric effect.

23. The ink-jet imaging apparatus according to claim 10, ~~wherein the above ink ejection element is a heater element which~~ generates heat, or a piezo element which causes a piezo electric effect.

REMARKS

The above amendments are presented in order to put the multiple dependent claims in non-multiple dependent format.

Respectfully submitted,

James H. Walters, Reg. No. 35,731

802
DELLETT AND WALTERS
Suite 1101
310 S.W. Fourth Avenue
Portland, Oregon 97204 US
(503) 224-0115
DOCKET: I-184

MARKUP SHEET OF CLAIM AMENDMENTS MADE HEREIN

3. (Amended) The ink-jet imaging apparatus according to claim 1 [or 2], wherein the controller functions to change timing of ink ejection of the ink ejection element in correspondence with the shape of the ink liquid face at the outlet of the nozzle.

6. (Amended) The ink-jet imaging apparatus according to claim 4 [or 5], wherein a memory is provided for memorizing preliminarily the prescribed time interval varying in dependence of the inside temperature of the printing head for each of the inside temperature, and

the controller may control both of the first ink ejection element and the second ink ejection element to eject the ink at intervals memorized in the memory based on the inside temperature detected by the temperature sensor.

7. (Amended) The ink-jet imaging apparatus according to claim 4[, 5, or 6], wherein the controller decides the number of times of simultaneous driving of the first ink ejection element and the second ink ejection element based on the temperature detected by the temperature sensor.

14. (Amended) The ink-jet imaging apparatus according to [any of claims 1 to 13] claim 1, wherein the above ink ejection element is a heater element which generates heat, or a piezo element which causes a piezo electric effect.

Mark UP

independently of the temperature outside the printing head. However, the ink ejection may become irregular or fail by formation and accumulation of a bubble in the nozzle owing to temperature difference between the inside and the outside of the printing head. The aforementioned ejection recovery system is effective to solve such a problem.

However, such an ejection recovery system takes long time for the recovery operation, since the system covers the nozzle outlet with a cap and sucks the ink from the nozzle by application of a negative pressure. Therefore, the recovery operation in each time of ejection failure will decrease the number of printed sheets for a unit time (the throughput being lowered).

In usual printing, the printing head is driven to scan immediately after the delivery of the recording paper sheet by a breadth of one printing band portion. Thereby, the time of the printing is kept constant, and the time interval of joining the front end of the printing region to the rear end of the printed region (joint between the printing bands) is constant. However, when the ejection recovery is conducted during the printing with the ejection recovery system, the time interval of the ink overlapping becomes larger at the adjacent printing band joint portion to change the time before the overlapping of the ink at the band joint portion. In other words, the ejection recovery by the ejection recovery system will lengthen the time of the drying of the ink having deposited at the preceding scanning on the recording paper sheet. This may cause change of the color tone at the ink overlap at the band joint, causing irregularity of color.

FOF

DISCLOSURE OF THE INVENTION

The present invention intends to provide an ink-jet imaging apparatus which is capable of removing a bubble or a foreign matter from

ejection face) of a printing head. Fig. 3 is a schematic plan view of heater elements and the like arranged on an aluminum base plate. Fig. 4 is a cross-sectional view of a nozzle of a printing head.

Fig. 2 shows many outlets 40a of the nozzles 40 arrayed in a nozzle line 42 on a bottom face (ink ejection face) of the printing head 22. The nozzles 40 are formed on a silicon base plate 44, and extend in the direction nearly perpendicular to the paper face of Fig. 2. The silicon base plate 44 is backed by an aluminum plate 46 for strengthening the silicon base plate 44.

Fig. 3 shows an ink ejection heater element line 50 formed on a downstream side in the ink ejection direction (arrow D direction) of the ink 41 (Fig. 4) on the surface of the base plate 46 for ink ejection from the nozzles 40 . This ink ejection heater element line 50 comprises image-forming heater elements 52 (an example of the first ink ejection elements in the present invention) which generates heat in accordance with image information signals to eject ink 41 to form an image, and ejection-recovering heater elements 54 (an example of the second ink ejection elements in the present invention) which allows ejection of the ink 41 from the nozzles in the time other than image formation.

The image-forming heater elements 52 and the ejection-recovering heater elements 54are provided in pairs for the respective nozzle 40 as shown in Fig. 4, the image-forming heater elements 52 being placed downstream in the arrow D direction after the ejection-recovering heater elements 54.

On the face of the base plate 46, on each of the end sides of the ink-ejection heater element line 50 (both sides in the direction perpendicular to the arrow D), there are provided a head-inside temperature detecting DI sensor 56 (an example of the temperature sensor

in the present invention) for detecting the inside temperature of the printing head 22. Outside the head-inside temperature detecting DI sensors ~~56on~~ 56 on the face of the base plate 46, are provided head temperature-adjusting heater elements 58 for adjusting the inside temperature of the printing head within a prescribed range.

All the image-forming heater elements 52 and all the ejection-recovering heater elements 54 are controlled by a head controller 11 (Fig. 1) to generate heat simultaneously at a prescribed timing. Herein the "prescribed-timing" means the timing of bubble formation in the nozzle 40, for example, caused by temperature difference between the inside and outside of the printing head 22. The simultaneous heat generation by the image-forming heater element 52 and the ejection-recovering heater element 54 causes ejection of a larger quantity of the ink 41 from the nozzle 40. Thereby any bubble or any foreign matter is removed by the ink flow. Such ejection of the ink 41 from the nozzle 40 for removal of a bubble or a foreign matter out of the nozzle 40 by simultaneous heat generation of the image-forming heater elements 52 and the ejection recovering heater elements 54 is herein called "recovery ejection". The recovery of ejection can be conducted in a short time by the recovery ejection since it can be conducted simply by simultaneous heat generation of the image-forming heater elements 52 and the ejection-recovering heater elements 54. By this recovery ejection, the bubble and the foreign matter in the nozzle 40 are ejected together with the ink 41, and thereby the bubble, the foreign matter, and dried ink residue are removed from each of the nozzles to recover the normal state of the nozzle 40 (state of no-bubble and no-foreign matter).

Only a short time is necessary for ejecting the ink 41 by simultaneous heat generation of the image-forming heater elements 52 and the ejection-recovering heater elements 54. In contrast, the forcible